IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Eitan Zait et al. Art Unit: 1756

Serial No.: 09/950,038 Examiner: Martin J Angebranndt

Filed: Sept. 10, 2001

For: METHOD AND APPARATUS FOR THE MANUFACTURING OF RETICLES

DECLARATION OF EITAN ZAIT UNDER 37 CFR §1.132

Commissioner of Patents
Washington, D.C. 20231

SIR:

I, Eitan Zait, hereby declare as follows:

1. I am very familiar with laser technologies and in particular with pulse-laser technologies. I hold a M.Sc. degree in Physics from Technion, Israel's Institue of Technology, Haifa, IL. I have been working in the semiconductor industry (KLA-Tencor) since 1995 and in research and development connected with pulse laser technologies since 2001. I am employed by UCLT Ltd. (formerly U.C. Laser Ltd.), an Israel company specializing in pulsed laser technologies as Manager of R&D. UCLT Ltd. Is the Assignee of the present application.

2. I have reviewed the disclosure of U.S. Patent Application Serial No. 09/950,038 (hereinafter – the present application). I am familiar with the invention disclosed therein, being the first named inventor.

3. As discussed in the specification, the invention disclosed in the present application deals with two aspects relating to photomasks:

a) Writing patterns on the coating of a reticle using ultrashort laser pulses (femto-second laser) directed at the coating, or just short of the coating, through the back side of a reticle and the substrate (Figures 1a, 1b and related text).

b) Providing phase shift elements below a known pattern on a reticle to enhance contrast or fix errors in the pattern (Figures 3a, 3b and related text).

4. I have reviewed the statements made by the Examiner in the Office Action dated July 20, 2004, as well as the references cited by the Examiner. I am of the opinion that the references cited by the Examiner do not suggest or disclose the invention claimed and should not preclude the Examiner from allowing the claims of the present application.

5. Hongo 759 (Hitachi) teaches writing on the chrome layer through the back of the mask (through the substrate). This is direct writing on the chrome layer, using nano-second pulses, which by themselves, moreover, are practically "continuous", with respect to ultra-short pulses (femto-second pulses).

6. Haight (IBM) – "MARS" suggests writing on the coating by focusing a laser beam above the coating (this is done from the front-side).

7. Gelbert et al. (818) deals with phase shifting patterns that are inscribed on the coating in the form of grooves.

8. Ito (JP 2000-056112) deals with writing three-dimensional diffractive elements within a transparent medium. This is something almost trivial – one can find in souvenir-shops blocks of glass (in many sizes) with three dimensional images inscribed inside. This exists for many years (much earlier than the Japanese paper).

9. The combinations of these references, as done by the Examiner in his last Action, seems to be inappropriate as there is (1) no connection between the references themselves other than their being in the general field of laser technologies (not necessarily in the femto-second laser realm) and (2) no motivation for an art-skilled person to combine the references as the Examiner has.

10. As to the first aspect of the present invention (as claimed in claims 1-12, 24 in the proposed amendment to the claims submitted with a response to the above mentioned Action together with this deposition), the references do not suggest focusing pulsed laser radiation at the back-side of the coating layer, inside the substrate. Claim 2 specifically claims the zone where the focused radiation lies to be up to 50 microns from the front side of the coating layer.

11. We have implemented the claimed method and obtained very good results obtaining very high accuracy and resolution. Photographed examples are enclosed as Annex A, showing an image of lines of pixels inside glass, made using the technology disclosed and claimed in the present patent application. Since the line patterns are due (mostly) to refractive index change, they could be detected

only with a phase contrast microscope, which was used for photographing the image in the glass.

12. As to the second aspect of the invention (as claimed in Claims 25-40 in the proposed amended claims), the provision of phase shifting is aimed at refining the pattern projected using a mask. The projected pattern is, of course, determined by the pattern inscribed on the mask itself, yet phase shifting elements can refine the projection and obtain better details, better printed contrast, greater resolution and therefore better overall performance.

13. Up until now phase shift formation was used only on the coating or surface of the mask, in the form of physical grooves provided on the coating surface (MoSi) or on glass surface itself. This was proven to be satisfactory but not good enough for extra-fine details. The fact that three-dimensional formations may be used also plays a role in making this a superior way of treating masks and refining their projected patterns. Three-dimensional structures widen the parameter-window, by adding one more controllable dimension to phase control.

14. Phase shift on its own is not new, nor using it in the mask industry (in the form of physical grooves on the coating layer or glass surface), yet the present invention has brought about intra-volume phase shift formations, which are superior to phase shift grooves, and which is a higher yield process. This method is not merely a substitute for surface grooves; rather, it is substantially better and more efficient.

15. The production process of intra-volume phase shift elements involves a single step process (writing inside the substrate the elements using a pulsed laser), unlike physical grooves, which involve processing in up to five stages (lithography). In fact, ever since the Assignee company has disclosed this technique to the industry, there has been great interest shown in this technique by big players in the industry, and it is understood that this is because the novel technique produces results that are clearly much more superior and provide a higher yield than the old physical grooves techniques. Some of the largest integrated-circuit manufacturers in the semiconductors industry are currently investigating this technique (in collaboration with our company) in their production lines.

16. Another advantage of the intra-volume phase shift formation of the present invention is the ability to reiterate fixing of defects by adding another phase shift element, where the first one had failed to perform as required. We have conducted series of jobs where this was implemented. More details are provided in Annex B, where an image of 4 dens arrays of pixels are patterned inside glass. The first one with a single layer, the second with two and so on. The four patterns are a mere representation of the capability of this invention to pattern phase shift elements with two- and three-dimensional structures. The final effect of phase shift needs to be measured directly on actual printed silicon wafers, where a phase shift element is near the chrome coating pattern.

The undersigned declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are

believed to be true; and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under section 1001 of title 18 of the United States Code and such willful false statements may jeopardize the validity of any patent issuing thereon.

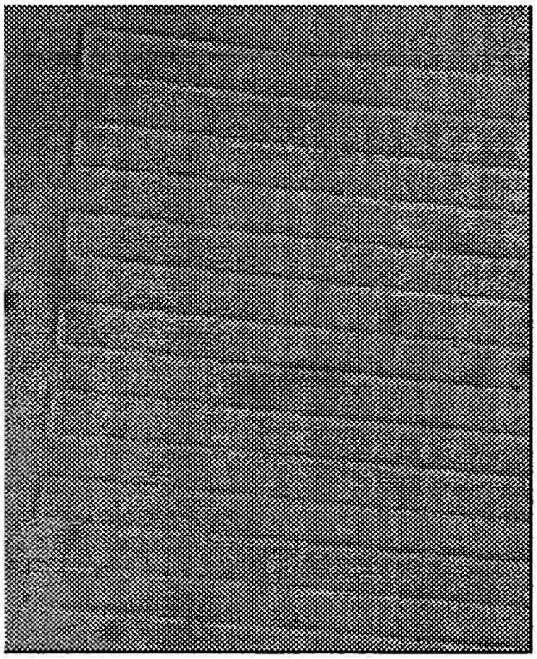
Date: 14 Nov. 2004

Eitan Zait

Eitan Zait

Appendix A

Image of lines of pixels patterned inside a Quartz reticle via the back side of the reticle, near front surface.
Lines width is 0.8 microns and pitch (between lines) is 10 microns.
Image grabbed with a Phase-contrast microscope.

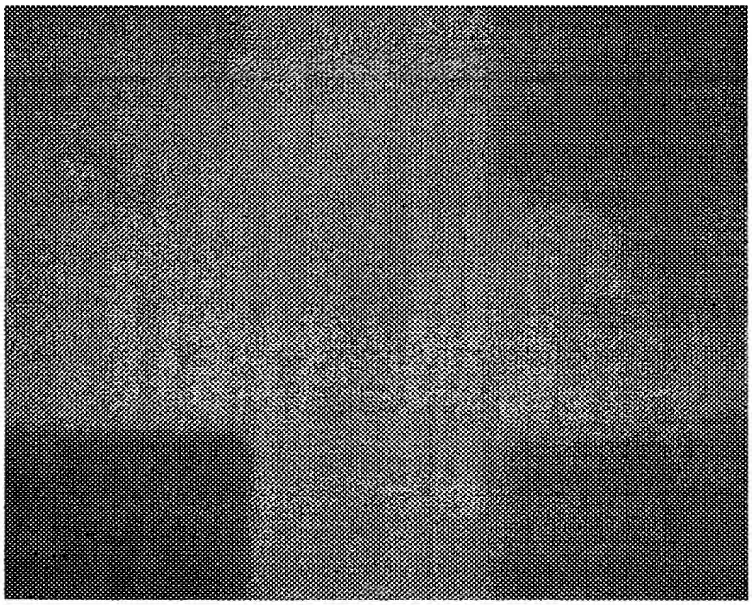


Appendix B

Four pixels arrays at corners, patterned inside glass - 4 dens arrays of pixels were patterned with pitch of 2 microns, the first one with a single layer (top left), the second with two (top right), third with three layers (bottom right) and the fourth with four layers (bottom left).

in(i.e. three dimensional application of the phase-shift elements).

Image grabbed with a Phase-contrast microscope.



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Serial No.:	09/950,038
Applicant:	Eitan Zait, et al.
Filing Date:	September 10, 2001
For:	Method And Apparatus For The Manufacturing Of Reticles
Enclosures:	(1) Amendment (15 pages); (2) Executed Declaration of Eitan Zait (8 pages); (3) Petition for 2-month Extension of Time (1 page) w/Check in the amount of $225.00; (4) Acknowledgment postcard.